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ASSOCIATION OF PLASMA PROCALCITONIN WITH VARIOUS COMPONENTS OF METABOLIC SYNDROME AND INSULIN RESISTANCE

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Abstract: Background:
The study investigates the relationship between insulin resistance and metabolic syndrome and plasma procalcitonin, a biomarker of inflammation. The metabolic syndrome, a collection of disorders that includes dyslipidemia, hypertension, hyperglycemia, and abdominal obesity, raises the risk of type 2 diabetes and cardiovascular illnesses. One of the main elements of metabolic syndrome is insulin resistance. Adipocyte dysfunction and persistent low-grade inflammation may be markers for elevated levels of plasma procalcitonin, which have been linked to higher measures of obesity, metabolic syndrome components, and a higher chance of developing insulin resistance and metabolic syndrome.
Objectives:
To investigate the correlation between plasma Procalcitonin (PCT) and metabolic syndrome components such as abdominal obesity, dyslipidemia, hypertension, hyperglycemia, and insulin resistance, in comparison to healthy individuals.

Result: In this study, 80 healthy participants served as controls, while 120 patients with metabolic syndrome (MetS) were included. Procalcitonin (PCT) levels were found to be

considerably higher on average in MetS patients as compared to controls in the study. In particular, the average PCT level for MetS patients was 0.122±0.168 ng/ml, compared to 0.086±0.0047 ng/ml for controls. Given that there was a statistically significant difference between the two groups, PCT may have application as a MetS biomarker.
Subsequent investigation demonstrated a strong relationship between PCT and HOMA-IR-measured insulin resistance. The two had a 0.187 Pearson correlation coefficient, and the p-value was less than 0.05. Furthermore, a number of Metabolic Syndrome components, including BMI, waist circumference, triglycerides, VLDL, hypertension, and fasting blood glucose, were found to significantly correlate with PCT. Nevertheless, no meaningful association between PCT and LDL-C was discovered. Conclusion: The study found that the mean level of procalcitonin (PCT) was significantly higher in patients with metabolic syndrome (MetS) compared to controls.

Key words: Procalcitonin, Metabolic Syndrome, Insulin Resistance, obesity.

Introduction

Worldwide, metabolic syndrome is a prevalent health problem that affects a sizable population. At least three of the five metabolic risk factors—abdominal obesity, hypertension, hyperglycemia, elevated blood triglyceride levels, and low serum HDL—must be present for the syndrome to be diagnosed. Because of the underlying insulin resistance, these factors when combined raise the risk of type 2 diabetes and cardiovascular illnesses. .[1][2]

There isn't yet a single laboratory measure that can accurately identify metabolic syndrome. Calculating insulin sensitivity is a laborious task. Consequently, it is crucial to develop a biomarker that can precisely identify insulin-resistant states and metabolic syndrome. All of the components of the metabolic syndrome, including insulin resistance, are significantly influenced by chronic low-grade inflammation. In response to systemic inflammation, procalcitonin, a polypeptide precursor of the hormone calcitonin, is released. It may be used as a biomarker to identify obesity-related low-grade inflammation early on. Nevertheless, little information is available regarding its application in India, where people with metabolic syndrome differ phenotypically.[15][4][5]

One of the main risk factors for metabolic syndrome is obesity, particularly when it affects the abdomen. Metabolic disorders like dyslipidemia, hypertension, and insulin resistance frequently coexist with it. Furthermore, it is widely accepted that the primary underlying cause of metabolic syndrome is obesity. .[6][7]

Body mass index (BMI), waist circumference, and waist-to-hip ratio are anthropometric risk variables that are commonly used to assess obesity and the likelihood of developing metabolic syndrome. These measurements are useful in assessing the distribution of body fat, a significant risk factor for metabolic syndrome. Excessive fat around the waist, or central obesity, is closely correlated with metabolic syndrome and other related disorders. .[8][9]

Comparing the plasma procalcitonin levels of patients with metabolic syndrome to those of healthy individuals was the aim of this case-control investigation. The purpose of the study was to look at the components of the metabolic syndrome and the relationship between procalcitonin levels and insulin resistance. Furthermore, the study sought to ascertain the relationship between plasma procalcitonin and metabolic syndrome problems at the time of presentation and during the initial short-term follow-up.

Participants and Methods

Patients who visited the diabetic center at Al Fayha Hospital between September 2022 and June 2023 were the subjects of a prospective case-control study. Permission for the study was given by the institutional ethics committee. After obtaining their voluntarily informed consent, patients with metabolic syndrome who were older than 18 years old were chosen as cases (n=120). The International Diabetes Federation (IDF) consensus 2006 definition9, which includes an elevated waist circumference (cutoff > 42 inches for men and ≥ 38 inches for women) plus any two of the following, was used to define metabolic syndrome. Triglycerides greater than 150 mg/dL or triglyceride treatment; HDL cholesterol less than 40 mg/dL in men and less than 50 mg/dL in women or HDL treatment; treatment for hypertension; fasting plasma glucose ≥ 100 mg/dL; medication for type 2 diabetes; systolic or diastolic blood pressure greater than 130 or 85 mm Hg. Patients on lipid-lowering drugs, and those who had any evidence of infections were excluded. Age and sex-matched healthy volunteers were recruited as controls (n=80).

Results:

Table 1 presents the distribution of patients with Metabolic Syndrome and control subjects based on their socio-demographic variables. The age of the subjects ranged from 27 to 78 years, with most patients with MetS and controls being aged between 35 to 44, with frequencies of 35.0% and 38.75%, respectively. However, the age group of ≥65 had the lowest proportion, with comparative frequencies of 8.33% and 7.50%, respectively. The overall mean age for patients with MetS and control subjects was 49.43±11.76 years and 48.45±11.20 years, respectively.

Table 1. Socio-demographic characteristics of patients with M.S, and control subjects.

Characteristic			Subject	
			Control N=80	M.S N=120
Age(years)Mean ±SD			48.45±11.20	49.43±11.76
Age	25-34	Count	6	9
		% of Total	7.5%	7.5%
	35-44	Count	27	28
		% of Total	33.75%	23.33%
	45-54	Count	26	44
		% of Total	32.5%	36.66%
	55-64	Count	12	27
		% of Total	15.0%	22.5%
	≥65	Count	9	12
		% of Total	11.25%	10.0%
Gender		Male	41(51.2%)	59(49.2%)
		Female	39(48.8%)	61(50.8%)
Education		Primary	17(21.25%)	22(18.33%)
		Secondary	11(13.75%)	18(15.00%)
		Institute	52(65.00%)	80(66.66%)
Smoking		Smoking	28(35.0%)	39(32.8 %)
		Ex-smoker	0(0.00%)	6(5.0%)
		Non-smoking	52(65.00%)	74(62.2 %)
Residency		Urban	75(93.75)	109(90.83%)
		Rural	5(6.25)	11(9.16%)

As demonstrated in Table 2, the study discovered that individuals with Metabolic Syndrome (MetS) had a considerably higher Body Mass Index (BMI) than control subjects ($P < 0.01$). Furthermore,

as shown in Table 3, individuals with MetS had higher diastolic and systolic blood pressures (DBP and SBP, respectively) than control subjects (P0.01). Furthermore, as indicated by Table 4, patients with MetS in both genders had greater waist circumferences (WC) than control subjects (P < 0.01). Patients with MetS also had greater rates of hypertension and diabetes mellitus (DM) than did the control group. In particular, none of the control subjects had hypertension, whereas 44.2 percent of the MetS patients had. As demonstrated in Table 5, DM was present in 82.5 percent of all MetS patients but not in any control cases.

Table 2. BMI measurement study groups.

			Subject		Total
			MetS	Control	
BMI1	20-24.9	Count	8	37	45
		% within Subject	6.7%	46.3%	22.5%
	25-29.9	Count	35	42	77
		% within Subject	29.2%	52.5%	38.5%
	30-34.9	Count	41	0	41
		% within Subject	34.2%	0.0%	20.5%
	35.39.9	Count	26	0	26
		% within Subject	21.7%	0.0%	13.0%
	40>	Count	10	1	11
		% within Subject	8.3%	1.3%	5.5%
Total		Count	120	80	200
		% within Subject	100.0%	100.0%	100.0%

Table 3. Systolic and Diastolic measurement among study groups.

	MetS	**Control**	**P-value**
	Mean± SD	Mean± SD	
SBP	142.01±12.33	121.56±7.17	0.000
DBP	85.53±9.45	76.86±6.25	0.000

Table 4. Waist Circumference measurement among study groups.

	MetS	**Control**	**P-value**
	Mean± SD	Mean± SD	
WC(cm) in men	45.59±5.85	35.30±2.78	0.000

WC(cm) in women	43.22±3.49	32.66±1.87	0.000
Total	44.40±4.67	33.98±2.32	0.000

Table 5. The prevalence of Hypertension and Diabetes Mellitus measurement among study groups.

			Subject		Total
			MetS	Control	
Hypertension	**Non-HTN**	Count	67	80	147
		% within Subject	55.8%	100.0%	73.5%
	HTN	Count	53	0	53
		% within Subject	44.2%	0.0%	26.5%
Total		Count	120	80	200
		% within Subject	100.0%	100.0%	100.0%
DM	**Non-DM**	Count	21	80	101
		% within Subject	17.5%	100.0%	50.5%
	DM	Count	99	0	99
		% within Subject	82.5%	0.0%	49.5%
Total		Count	120	80	200
		% within Subject	100.0%	100.0%	100.0%

According to the study, cases had greater plasma procalcitonin (PCT) levels than controls. The PCT level was 0.086±0.0047 ng/ml (range 0.002-0.093 ng/ml) in controls and 0.122±0.168 ng/ml (range 0.081-0.152) in cases. There was a statistically significant difference. Additionally, the study showed a strong link (Pearson correlation coefficient 0.187; $p<0.05$) between the Insulin Resistance level as evaluated by HOMA-IR and the PCT level (please refer to Figure 1).

Furthermore, the research demonstrated a substantial positive correlation ($p<0.01$) between PCT and a number of MS components, including BMI, waist circumference (please see Figure 6), S. Triglycerides (see Figure 3), S. VLDL (see Figure 5), hypertension, and fasting blood glucose (see Figure 2). PCT and LDL-C, however, did not exhibit a significant connection (p-value 0.902). (please refer to Table 6).

Table 6. The correlation coefficient for different Metabolic Syndrome components and insulin resistance.

		BMI	WC	Hyper tension	FBS	Chole sterol	Trigly ceride	LDL-C	VLDL	HDL-C	HOMA-IR
Procalcitonin	Pearson Correlation	0.682**	0.516**	0.444**	0.547**	0.237**	0.605**	0.009	0.625**	-0.459**	0.187*
	P-value	.000	0.000	.000	.000	.001	.000	.902	.000	.000	.040

*. Correlation is significant at the <0.05 level (P-value).

**. Correlation is highly significant at the <0.01 level (P-value).

Figure 1. Correlation between Procalcitonin and HOMA-IR

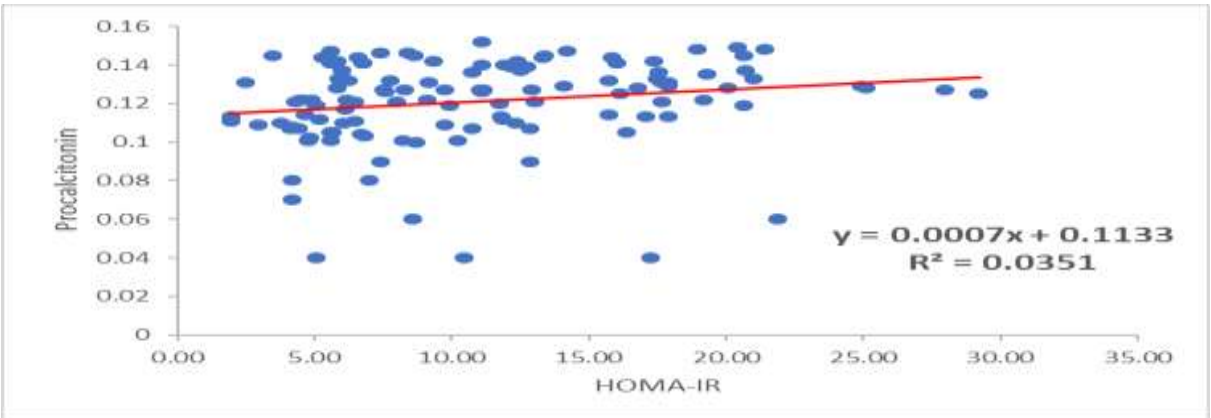


Figure 2. Correlation between Procalcitonin and Fasting Blood Sugar

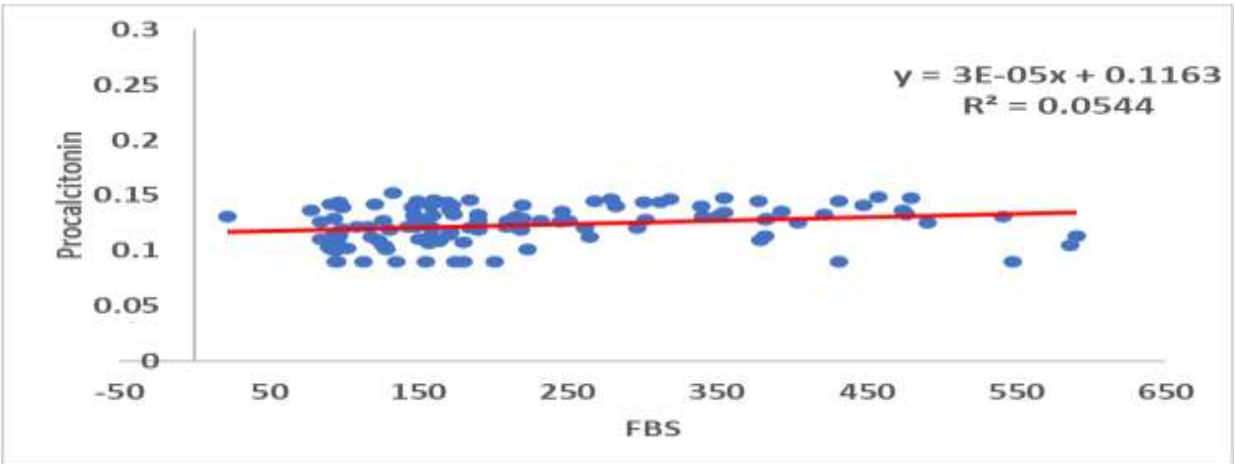


Figure 3. Correlation between Procalcitonin and Triglyceride

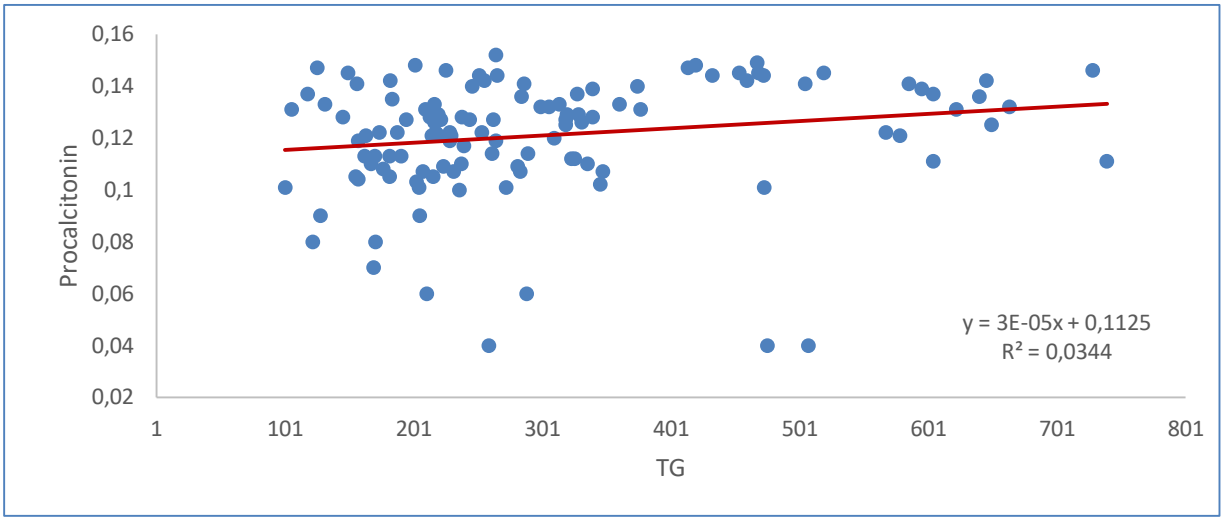


Figure 4. Correlation between Procalcitonin and HDL-C

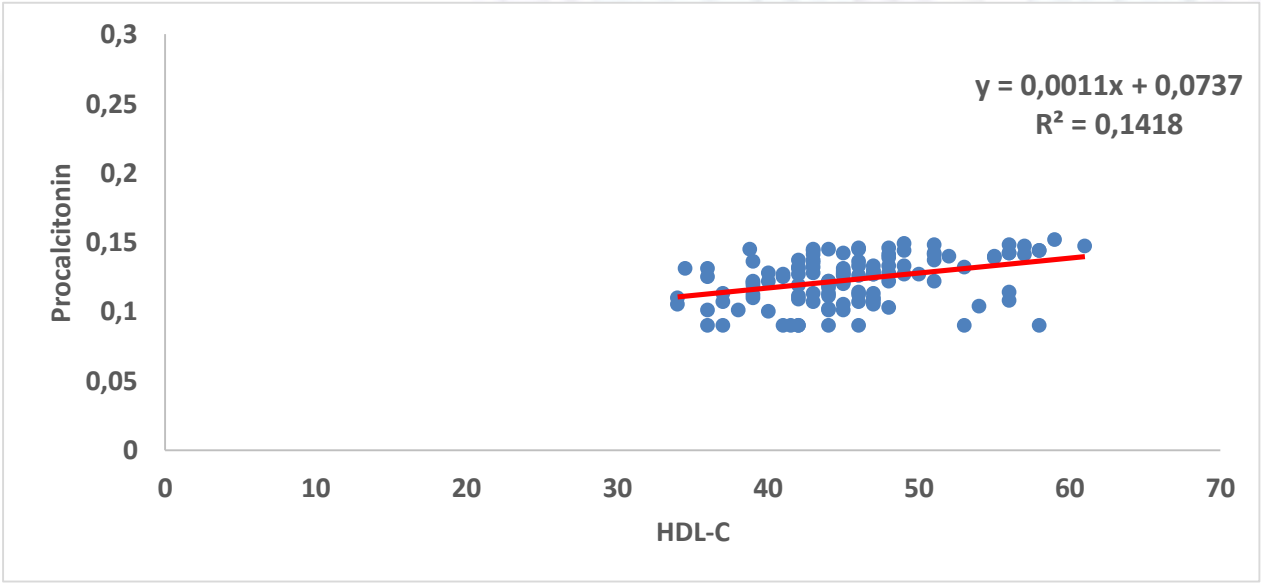


Figure 5. Correlation between Procalcitonin and VLDL

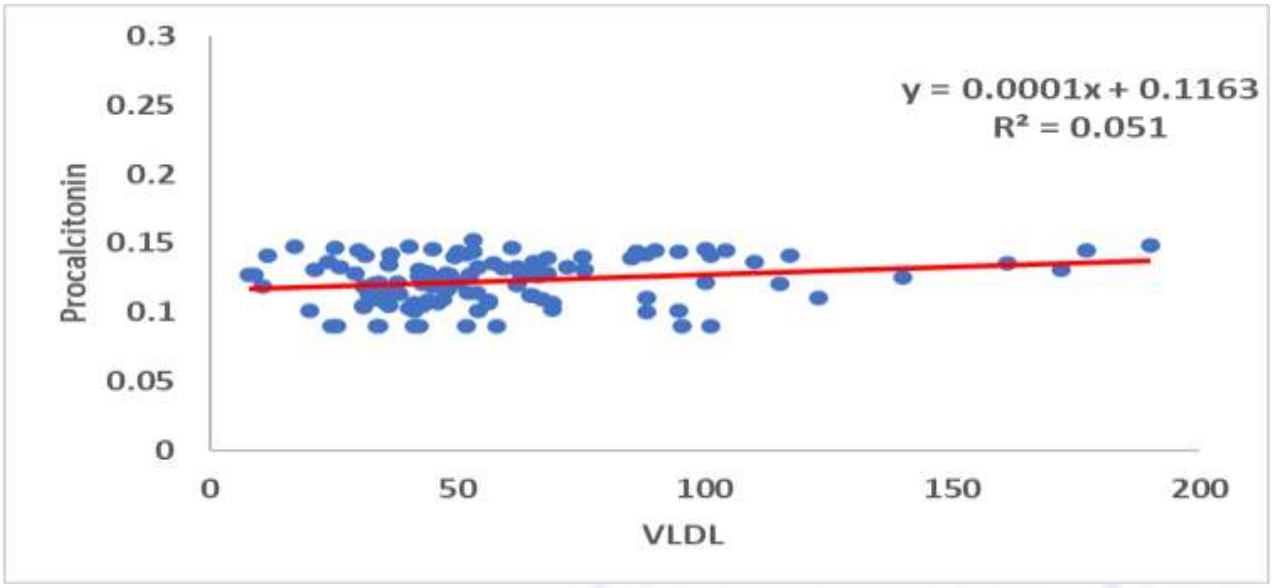
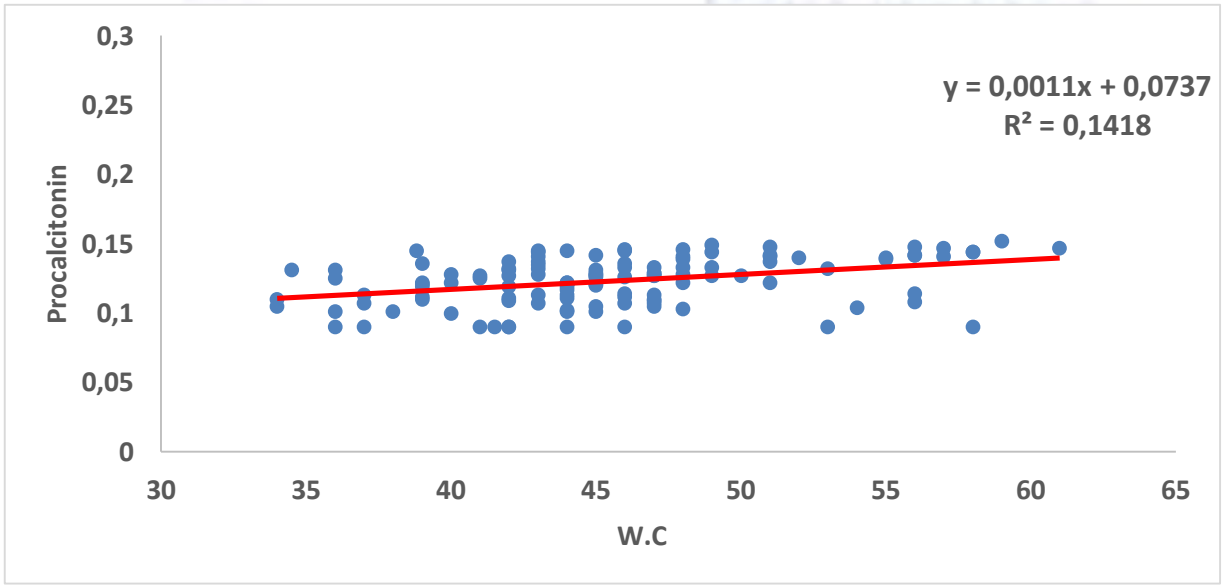


Figure 6. Correlation between Procalcitonin and waist circumference



Discussion:

The age distribution of the subject group is 11.20 years with a mean of 48.45 years. Conversely, the control group's mean age, with a standard deviation of 11.76 years, is slightly higher at 49.43 years. Five further categories are created from the age distribution: 25–34, 35–44, 45–54, 55–64, and 65 and above. The subject group's greatest age group is in the 35–44-year-old range (33.75 percent), whereas the control group's largest age group is in the 45–54-year-old range (36.66 percent).

In both groups, the gender distribution is about equal, with a little higher proportion of men than women. There are 51.2 percent males and 48.8 percent females in the subject group, compared to 49.2 percent males and 50.8 percent females in the control group. According to the International Diabetes Federation (IDF) criteria, metabolic syndrome (MetS) is relatively widespread in adults, with a gender distribution of 45.6 percent in males and 54.3 percent in women, according to a study on the Indian population. .[10] This is consistent with our study's findings of a high prevalence of MetS in both the subject and control groups.

The majority of both groups have an institute level of education (65.00% for the subject group and 66.66% for the control group).

Regarding smoking habits, the vast majority of individuals in both groups do not smoke (65.00 percent for the subject group and 62.2 percent for the control group). There are no ex-smokers in the subject group and a minor percentage in the control group (5.0 percent).

With a tiny minority residing in rural areas, the bulk of both groups—93.75 percent for the subject group and 90.83 percent for the control group—live in metropolitan areas.

The study's background and the interpretation of its findings may depend heavily on this demographic and lifestyle data. For example, the incidence of insulin resistance and metabolic syndrome, as well as the levels of plasma procalcitonin, may vary depending on factors like age, gender, education level, smoking status, and place of residence.

The study found that patients with MetS had higher BMI, SBP, DBP, and WC than control subjects. This is consistent with other research showing obesity to be a major risk factor for Metabolic Syndrome. The results of the study showed that, in comparison to control subjects, patients with Metabolic Syndrome (MetS) had greater body mass index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP), and waist circumference (WC). In comparison to control people, patients with MetS also had increased rates of hypertension and diabetes mellitus (DM). In particular, hypertension was present in 44.2% of all MetS patients, whereas it was absent in all control subjects. In a similar vein, DM was present in 82.5 percent of all MetS patients, but not in any control group. A study investigating the effects of alpha lipoic acid supplementation on patients with MetS found that these patients had a higher BMI and WC at the baseline of the study.[11]

Similarly, BMI and WC were considerably higher in MetS patients compared to controls in a study comparing the Atherogenic Index of Plasma, Lipid Accumulation Product, and Visceral Adiposity Index with components of the metabolic syndrome. .[12]

In terms of the prevalence of hypertension and DM in MetS patients, a review article reported that hypertension is present in almost 80% of patients with MetS.[13] This is higher than the 44.2% prevalence

of hypertension in MetS patients found in our study. However, the prevalence of DM in MetS patients in other studies is not explicitly mentioned in the search results.

The study also discovered that there was a strong correlation between PCT and BMI, waist circumference, triglycerides, VLDL, hypertension, and fasting blood glucose, with PCT levels being greater in cases than controls. One biomarker used to detect and track bacterial infections is PCT. According to the study, PCT might be a helpful biomarker for MetS as well. Based on the associations shown between PCT and BMI, waist circumference, triglycerides, VLDL, hypertension, and fasting blood glucose, it appears that PCT could be a valuable diagnostic and monitoring tool for metabolic syndrome.

Plasma procalcitonin was found to be considerably greater in cases with metabolic syndrome (mean 0.11 ng/ml) compared to controls (mean 0.002 ng/ml) in a study done at SMS Medical College in Jaipur. Additionally, the study discovered a strong correlation between PCT and S. triglycerides, neck circumference, waist circumference, and insulin resistance. The researchers came to the conclusion that higher plasma procalcitonin levels within the normal range are linked to higher levels of insulin resistance, metabolic syndrome components, and obesity-related indicators.[14]

A different investigation on an Indian urban population discovered that patients with metabolic syndrome had plasma procalcitonin much greater than that of healthy controls. Additionally, the study discovered a strong correlation between PCT and fasting blood glucose, waist circumference, triglycerides, and low-density lipoprotein (LDL). The researchers came to the conclusion that elevated levels of plasma procalcitonin within the normal range are linked to elements of the metabolic syndrome and insulin resistance, indicating that it may be a useful biomarker.[15]

A study on the general population found that plasma procalcitonin levels are associated with incident type 2 diabetes independent of common diabetes risk factors. The researchers suggested that further studies should be conducted on a potential role of the calcitonin-related system in the pathophysiology of diabetes.[16]

Conclusion

Studies have demonstrated that elevated plasma procalcitonin levels, even at slightly elevated levels within normal ranges, may be suggestive of insulin resistance and other components of metabolic syndrome. These include low levels of high-density lipoprotein (HDL), high levels of very low-density lipoprotein (VLDL), low levels of high-density lipoprotein (HDL), hyperglycemia, and abdominal obesity.

According to these results, procalcitonin may prove to be a very useful biomarker for identifying and keeping an eye on these disorders. Healthcare practitioners can learn a great deal about a patient's metabolic health and take the necessary precautions to prevent or manage the related health concerns by measuring procalcitonin levels in the blood.

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